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BULLETIN No. 1. A. S.—3

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF AGRICULTURAL SOILS

SOIL MOISTURE.

A RECORD OF

THE AMOUNT OF WATER CONTAINED IN SOILS

DURING THE

MONTH OF MAY, 1895.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGRICULTURAL SOILS,
Washington, D. C., August 1, 1895.

SIR: I have the honor to transmit herewith a report upon the amount of water contained in some important types of soil in different portions of the United States. The marked effect of different amounts of rain upon the yield and quantity of crops is familiar to all in the everyday experience of farmers. It will be seen from these records that, owing to the difference in the texture of soils, even with the same amount of rainfall, soils retain very different amounts of water. As crops require very different conditions of water for their best development, this difference in the water content of soils very largely accounts for the peculiar adaptation of certain soils to certain classes of crops. A good truck soil in a favorable season will contain about 5 per cent, or one-twentieth of its weight, of water; and grass land, on the other hand, should contain 20 per cent, or one-fifth of its weight, of water. These are characteristic differences due to the peculiar texture of these lands and their relation to water.

The actual amount of water contained in the soil determines the character of the season, the actual amount of rainfall being no reliable measure of this. These records show the actual conditions of moisture available to plants in these soils. It is not possible at present to draw reliable deductions from these records until more data is collected, and they are therefore given for the present with little comment.

Respectfully,

MILTON WHITNEY,
Chief of Division.

Hon. CHAS. W. DABNEY, Jr.,
Assistant Secretary.

CONTENTS.

AMOUNT OF WATER CONTAINED IN SOILS.

INTRODUCTORY.

Samples of soil are received daily for moisture determinations from about fifty observers located on typical soil formations in different portions of the country. The samples are taken by a method not altogether satisfactory but the best which has yet been devised for this kind of work. A small brass tube, about an inch in diameter and 15 inches long, has a thin brass collar inserted in one end to reduce the friction on the inside of the tube. This end is then turned off so as to make a cutting edge. A mark is placed upon the tube 12 inches from this cutting edge. In taking the sample, the tube is driven into the ground to the 12-inch mark, then carefully withdrawn, and a rubber cap put over each end to prevent the soil from drying out. The tube, thus protected, is put into a sack and mailed to this Department, where a moisture determination is made by the usual methods. The sample amounts to about 100 grams, or approximately one-fourth of a pound.

Especial attention has been given this season to the moisture conditions in the truck soils of the Atlantic Coast, in the different types of tobacco soils in the Eastern States, and in the soils of the western or arid portions of Kansas and Nebraska.

The principal object of this work is to study the relation of soils to water and to keep a record of the amount of moisture maintained in soils adapted to different kinds of crops or in soils under different climatic conditions. It was necessary, in order to have the results strictly comparable, to adopt some uniform kind of treatment, and, as it was impossible to secure exactly the same conditions of cultivation in such widely separated localities, the uncultivated soil, kept free from weeds or vegetation of any kind, was adopted as the standard condition of comparison.

It was desired, however, to study the effects of different methods of cultivation, especially in the arid portions of Kansas and Nebraska, to test their influence upon conserving this moisture. Duplicate samples were therefore taken in these localities from plats under ordinary conditions of cultivation, from other plats which had been subsoiled and thoroughly cultivated subsequently, and from other plats which had been irrigated in order to study the conditions of moisture maintained

where the artificial application of water was practiced. Some of the observers had all of these conditions and others only two or three.

The practice of subsoiling has just come into great favor in central and western Kansas as a means of increasing the proportion of the rainfall which is absorbed by the soil and of providing in the soil a much larger storage capacity for water. In the process of subsoiling, where the ground is stirred to an unusual depth much of the soil is exposed to the air, and this tends to dry out the land. The first effect of subsoiling or of cultivation of any kind is to present more surface to the air and to dry out the soil which has been stirred. For this reason, subsoiling or any deep cultivation should be done a sufficient time before the crop is put in to insure a rain which shall thoroughly moisten the soil; otherwise the subsoiling may be very prejudicial to the crop.

CHARACTER OF THE SEASON.

The season in the Eastern States has been generally favorable for all farm crops. Observers from the truck, tobacco, and grass regions have generally reported favorable conditions of soil moisture for these respective crops.

In western Kansas and Nebraska the month of May was exceedingly dry, little or no rain falling until the last of the month. An observer wrote from western Kansas May 9 that wheat and oats were badly injured by dry weather, but that corn was doing well. On May 13 another observer wrote that so little rain had fallen up to that time that but little weed seed had germinated and cultivation had not been much needed. On May 19 another observer wrote that it had been exceedingly dry, no rain having fallen since the first of the month, when there had been light showers. Small grain was in danger, and it was so dry that corn was not coming up, and rain was needed badly for everything. During the whole month of May all reports stated that the season so far had been exceedingly dry and that high, hot winds had prevailed. On May 30 a good rain set in, and reports since then have been extremely favorable.

The work could not be started by the first of the month, and in most cases the records do not begin until the middle of May. The observers and the exact places of observation were selected by agents of the Department, and the soils were carefully selected to represent large areas of land. Large samples of the soil and subsoil were collected at each locality and sent to the Department for a thorough examination of the physical properties of the soils and a determination of their relation to water.

In some cases reliable records have been kept of the rainfall, but in other cases this has not been done in this preliminary work, so none of the rainfall records are given. When the work is thoroughly organized, these and other records will be kept and published with the moisture curves.

SOIL MOISTURE CONDITIONS DURING THE MONTH.

The amount of moisture present each day in the soils of the different localities is shown by curves on the accompanying illustrations. These illustrations, if properly understood, are much plainer than tables of figures, and show very much more strikingly the differences in the moisture contents of different soils than figures would. The records show much of interest, also much which can not be explained until a careful examination is made of the soils from each locality and the relation of the soils to water has been fully determined.

In the illustrations the vertical columns mark the days of the month, as indicated by the figures at the top of the diagram. The horizontal lines running across the diagram represent the percentage of moisture in the soil, as indicated in the column of figures on the left-hand side of the illustration, extending from 0 to 33 per cent. As a guide to the eye, the lines representing every 5 per cent of moisture are made heavier.

The records for each day of the month are put upon the form in their appropriate places. Thus, if on the 1st day of the month there is 8 per cent of moisture in the soil, a mark is placed in the column representing that day at a height corresponding to the figure 8 on the left-hand side of the page. If on the next day there is 12 per cent of moisture in the soil, a mark is made in the next column at a height corresponding with the figure 12, and so on for each day of the month. When these marks have all been placed, a permanent line is drawn through each of them, giving a more or less curved line according to the daily differences in the water contained in the soil. The marks are then rubbed out, and the curved line shows the monthly record. Where it is stated that there is 10 per cent of moisture in the soil, it means that on that date 10 per cent, or one-tenth of the weight of the soil in its natural position in the field, is water. When 20 per cent of water is present, it means that 20 per cent, or one-fifth of the weight of the soil as it lies in the field, is water.

WHAT THE RECORDS SHOW.

The records from the Eastern States show the conditions of moisture in three types of tobacco land. The data from Oxford, N. C., are from one of the typical bright tobacco lands of Granville County. The data from Newstead, Ky., are from a typical dark shipping tobacco soil similar to the dark shipping tobacco lands of Virginia and North Carolina. The moisture curve is higher in this than in the bright tobacco lands. This is due to the closer texture of the soil, and this difference in the conditions of moisture is characteristic of these two soils, and is mainly what gives each its peculiar value. These two types of soil frequently occur on the same farm, and with the same

rainfall over each this difference of moisture content is still maintained, owing to the difference in texture and relation of the soils to water.

The data from Greendale and from Lexington, Ky., are from heavy clay lands of the Trenton limestone formation. The lands are adapted to the white burley tobacco, as well as to grass and wheat. It will be seen that the soils contain more moisture than the shipping tobacco land at Newstead. At Greendale the moisture content of the bare, uncultivated plat was about the same as from the sod, but this can not be expected to continue as the season advances and changes. At Lexington the results already show that the grass is draining the moisture supply.

In the western parts of Kansas and Nebraska, where the rainfall is small and the conservation of the moisture which falls on the soil is of such vast importance, it was decided to study the conditions under ordinary methods of cultivation, subsoiling, and irrigation. The practice of subsoiling is so new in Kansas, however, that it was not possible to locate the observations on lands which had been subsoiled some time previously, and in most cases the subsoiling had been done shortly before the observations commenced and with no subsequent rains to moisten the subsoiled land.

The data from Colby, Scott City, Fowler, and Ellinwood for the month of May show that the soil under ordinary cultivation contained from 4 to 10 per cent more water than the prairie sod. In several cases the amount of moisture is more than doubled from the effect of cultivation during this dry month, and crops growing on it could have had twice as much water as on the sod land. The importance of this need not be enlarged upon here. At all four of these places the irrigated fields contained about 5 per cent more water than the field under ordinary cultivation, and from these records it would appear that in the judgment of these observers 18 or 20 per cent of moisture is the most favorable condition for their soil and crops, for this is the condition they maintain when they can control the water supply.

At Colby and Scott City the subsoiled field contained considerably less moisture than the field under ordinary cultivation. The reason for this is undoubtedly due to the fact that there had been no rain since the subsoiling had been done, and the act of subsoiling had dried out the ground. It will be seen that both of these soils absorbed more of the rainfall of May 30 than the soils under ordinary cultivation.

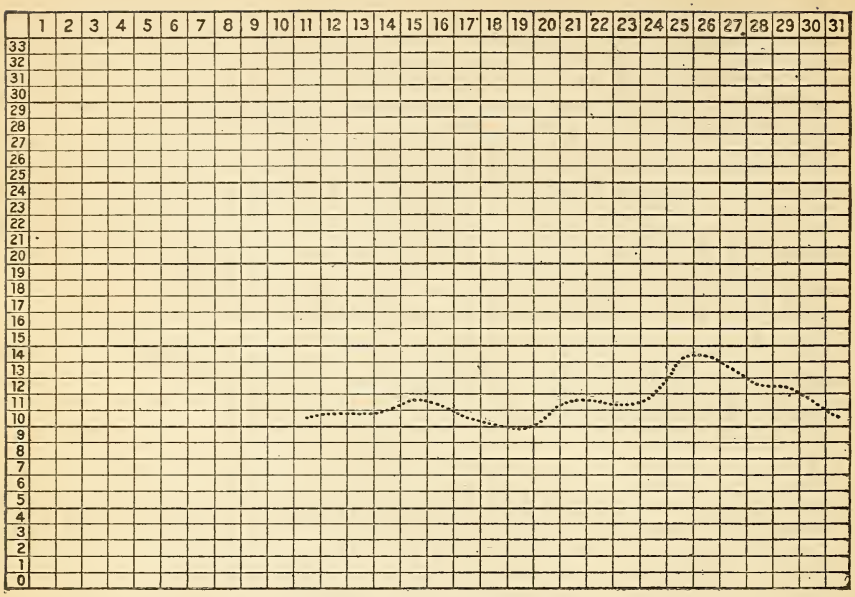
The results from Phillipsburg, Kans., are more difficult to explain. Here during this dry season there appears to have been less moisture in the soil which had been cultivated than in the uncultivated land. It appears that in this case cultivation was not only not beneficial, so far as the water supply was concerned, but was decidedly prejudicial. The examination of the texture of the soil will probably throw light on this.

At Wellington, Stafford, Mankato, and Haven, Kans., cultivation seems to have had little or no effect upon the water contents of the soils during this dry season. The results of the investigations of the texture and physical properties of these soils will probably throw light on these facts and give valuable suggestions as to the most intelligent methods of cultivation of these several varieties of soil.

The data from Geneva, Nebr., are from land which has been thoroughly cultivated in nursery stock for a number of years. The subsoiling had been done some time previous to taking the samples, and the results through the month of May show uniformly about 2 per cent more moisture in the subsoiled land over the fields under ordinary cultivation and about the same in this soil over that in the uncultivated.

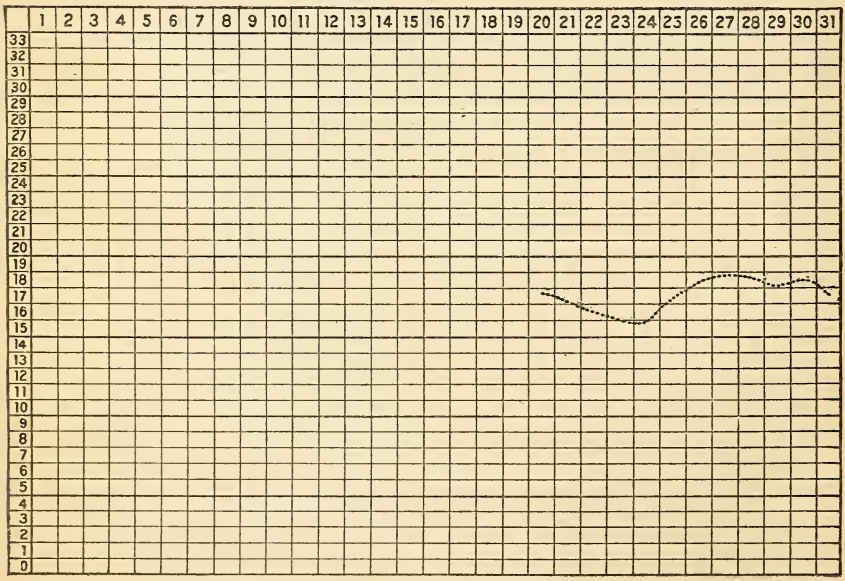
On May 30 a very general and abundant rain fell in all the localities in the West, and the relative position of the moisture curves has been very materially changed, as will appear in the charts showing the conditions for the month of June.

OXFORD, N. C.



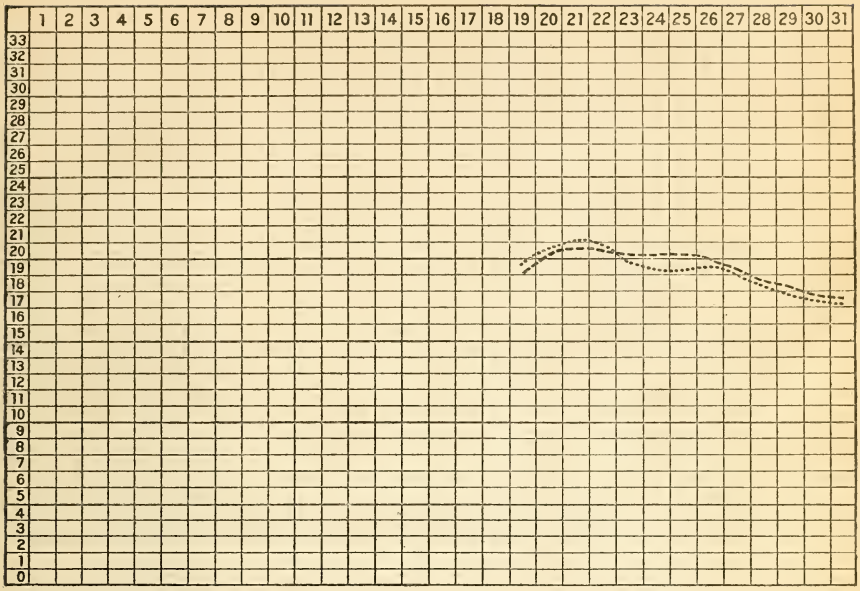
Bare, uncultivated bright tobacco land .....

NEWSTEAD, KY.



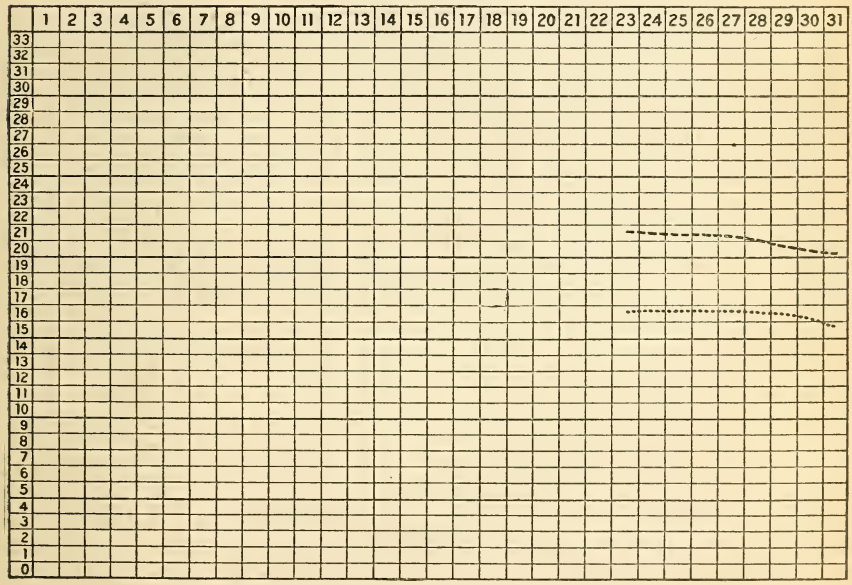
Bare, uncultivated shipping tobacco land .....

GREENDALE, KY.



Blue-grass sod ..... Bare, uncultivated

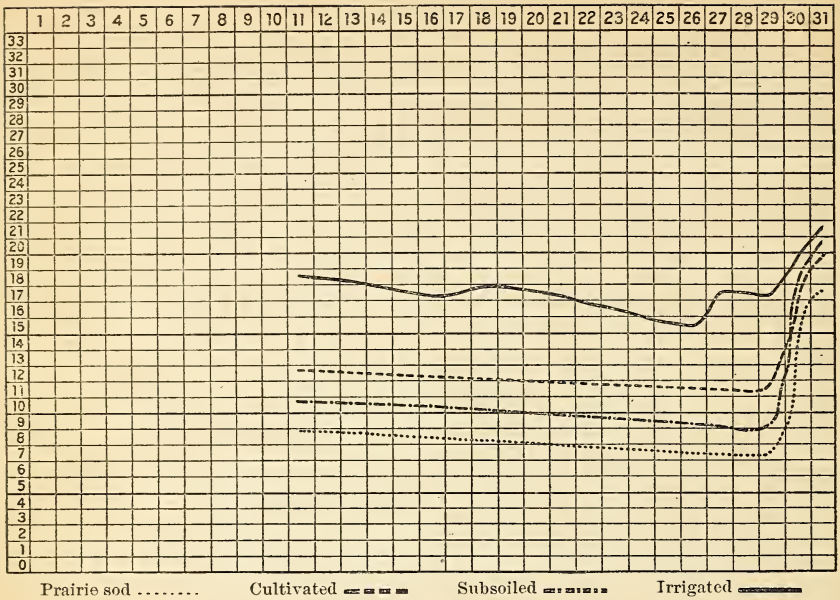
LEXINGTON, KY.



Blue-grass sod ..... Bare, uncultivated

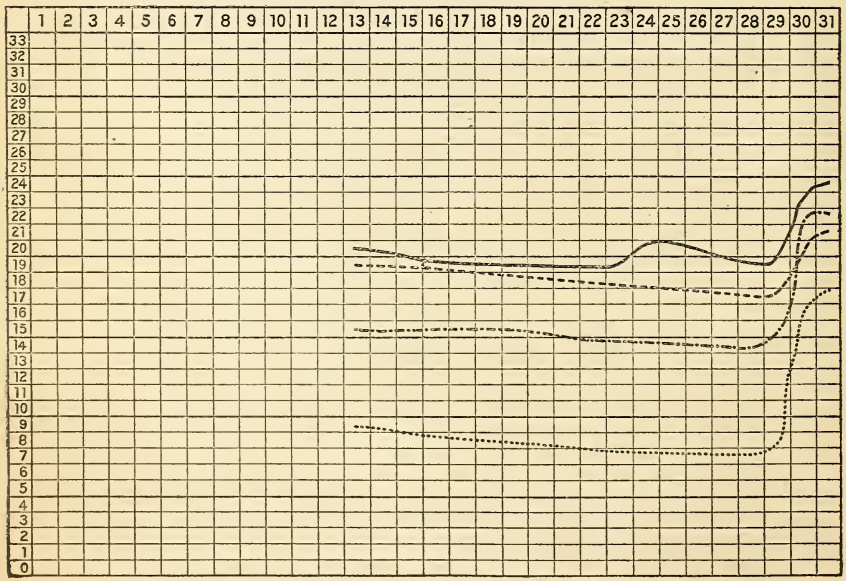
The grass is shown here to be a decided drain upon the soil moisture, the water contents of the land under the sod being less by 4 or 5 per cent than under the uncultivated. This is much more marked in the drier month of June.

COLBY, KANS.



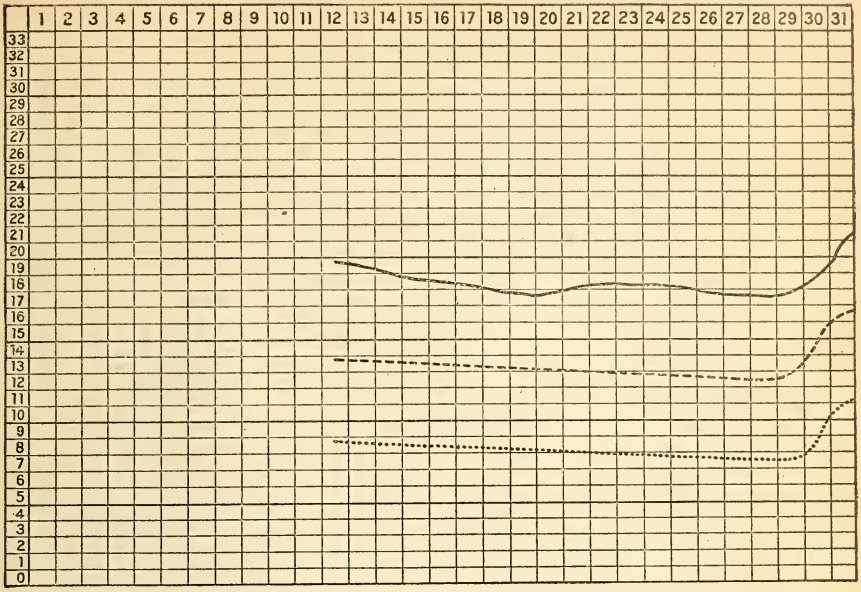
Ordinary cultivation has increased the amount of water held by the soil by about 50 per cent of the amount contained in the prairie sod, but it is still about 5 per cent less than the percentage in the irrigated field. The subsoiled field is drier than that under ordinary cultivation, as there has been no rain since the subsoiling has been done. It absorbs more of the rainfall of May 30 and 31.

SCOTT, KANS.



Cultivation has considerably more than doubled the amount of water in this soil over the prairie sod, and has maintained nearly as much as in the irrigated field. The subsoiled field contained considerably less moisture than that under ordinary cultivation, but the subsoiling was done late, and there had been no subsequent rain. On May 30 it appears to have absorbed more of the rainfall than the other fields.

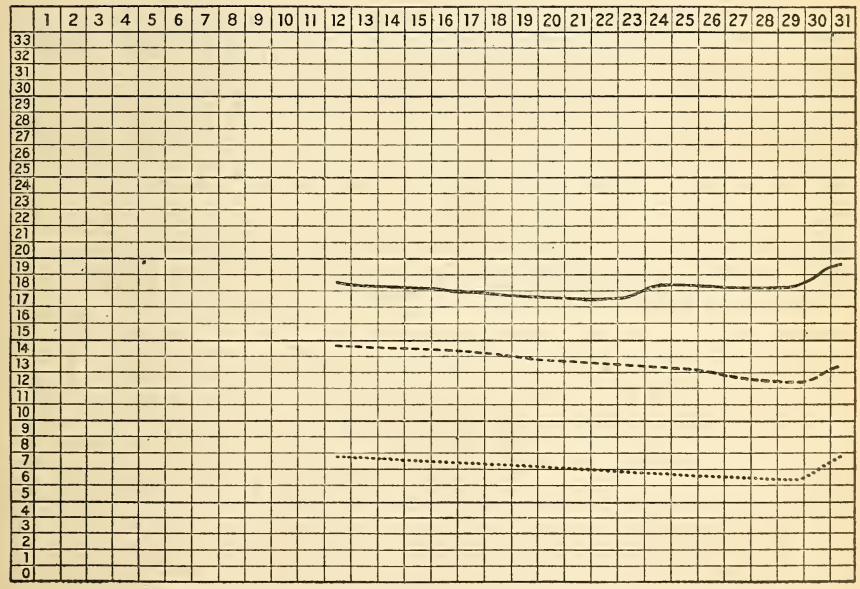
FOWLER, KANS.



Prairie sod ..... Cultivated ▬▬▬ Irrigated ▬▬▬

The cultivated field contained during this dry season 4 or 5 per cent more water than the prairie sod, but about 5 per cent less than the field which had been irrigated. The irrigated field contained over twice as much water as the prairie sod and 50 per cent more than the cultivated.

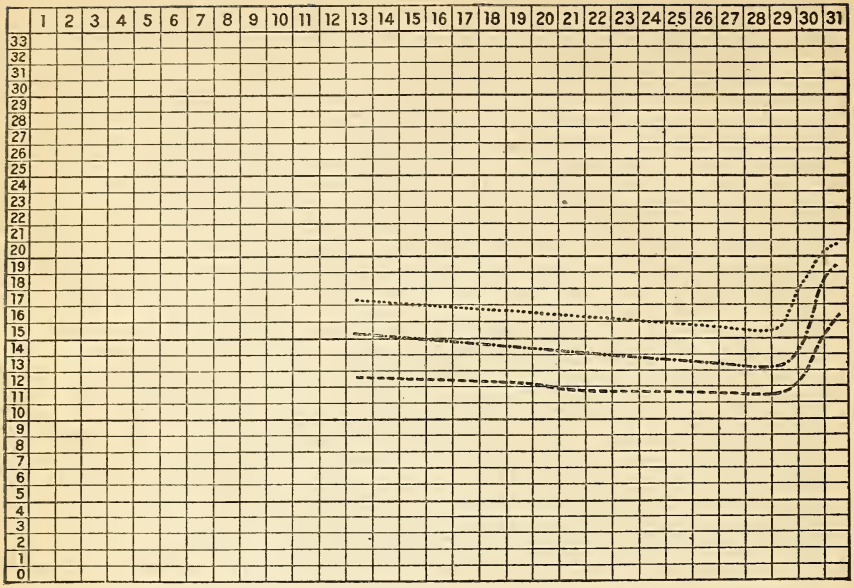
ELLINWOOD, KANS.



Prairie sod ..... Cultivated ▬▬▬ Irrigated ▬▬▬

The effect of ordinary cultivation has been to double the amount of water in the soil over the prairie sod during this dry season, but it is still 4 or 5 per cent less than in the irrigated field.

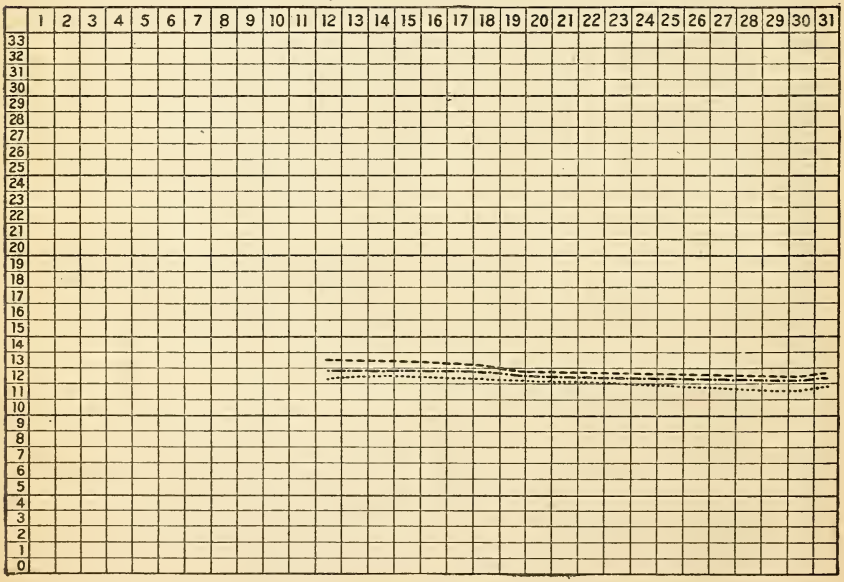
PHILLIPSBURG, KANS.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬·▬·▬

Neither subsoiling nor ordinary cultivation appears to have had any value in conserving the water in this land during this dry season, but on the contrary the subsoiled field contained about 2 per cent less and the field under ordinary cultivation 4 per cent less water than the uncultivated.

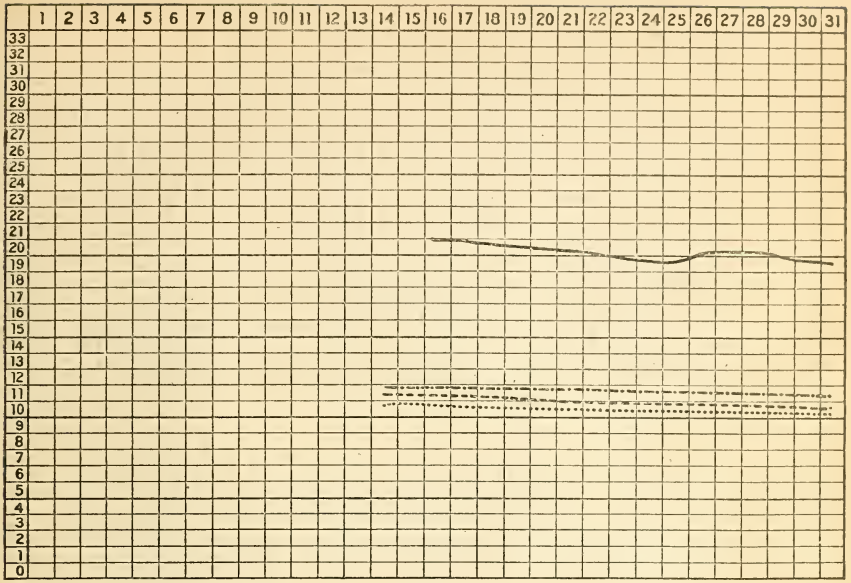
WELLINGTON, KANS.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬·▬·▬

Neither ordinary cultivation nor late subsoiling has had any material effect upon the water contained in this soil during this dry season.

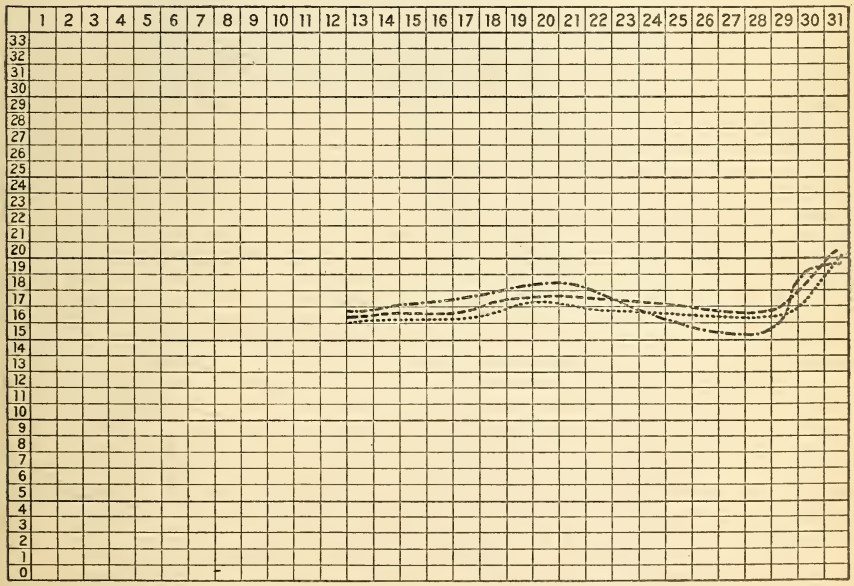
STAFFORD, KANS.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬ ▬ ▬ Irrigated ▬▬▬

Neither ordinary cultivation nor subsoiling has appeared to have any material effect upon the moisture contents of this land during this dry period. They appear to contain little more than half as much water as the irrigated field.

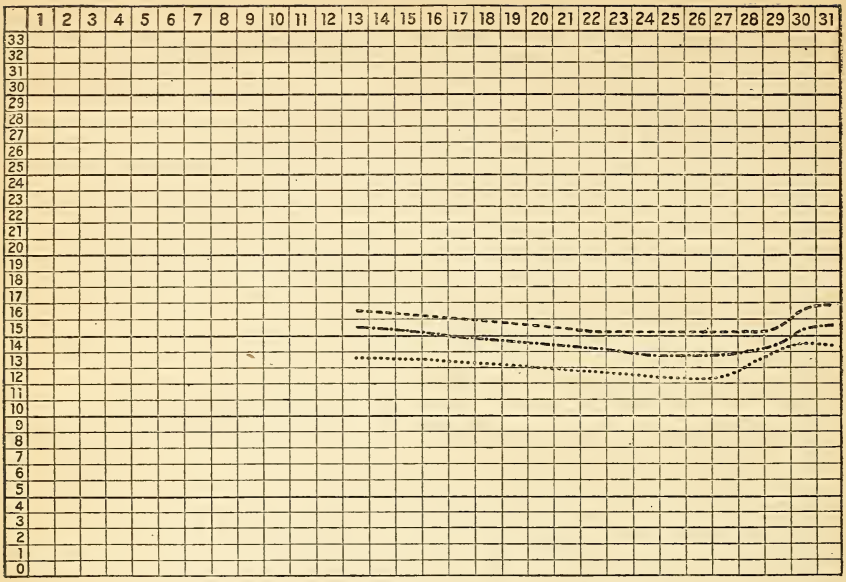
MANKATO, KANS.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬ ▬ ▬

Neither the ordinary cultivation nor the subsoiling appears to have had any material effect in increasing the amount of water held by this soil during this dry season. The soil nevertheless contained considerable water.

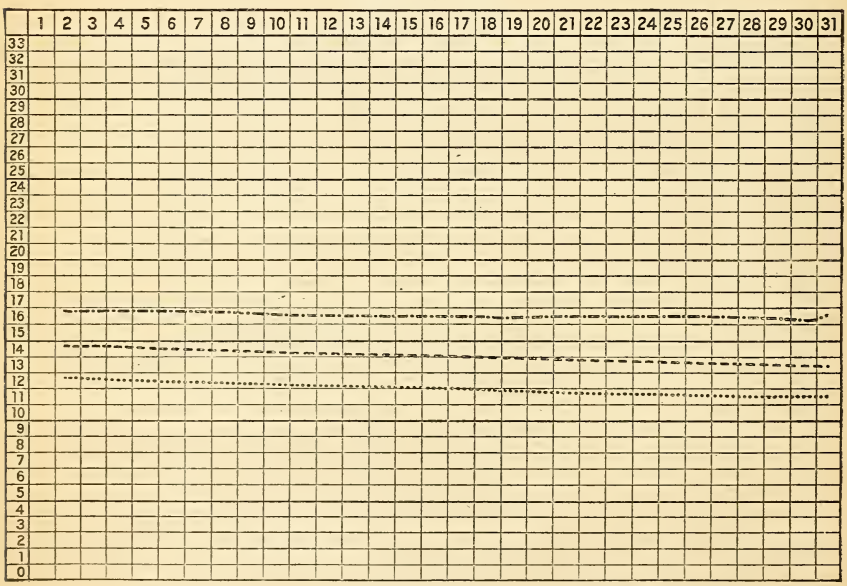
HAVEN, KANS.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬▪▬▪▬

Cultivation seems to have increased the water contents of this soil, as there is 2 or 3 per cent more than in the uncultivated land. The subsoiled field contained rather less than the field under ordinary cultivation, as the subsoiling was done late and there had been no rain subsequent to this.

GENEVA, NEBR.



Uncultivated ..... Cultivated ▬▬▬ Subsoiled ▬▪▬▪▬

This is the only place at which observations have been taken this season in which the subsoiling had been done a sufficient time before the crop was planted to insure a rainfall to wet the ground. The subsoiled field contained 4 or 5 per cent more water than the uncultivated and 2 per cent more than the field under ordinary cultivation.